Phonetic Factors in Existential Quantifier Interpretation

Research Thesis

Presented in Partial Fulfillment of the Requirements for Graduation *with Research Distinction in Spanish* in the Undergraduate Colleges of The Ohio State University

by

Matthew Galla

The Ohio State University
Spring 2020

Project Advisor: Dr. John Grinstead, Department of Spanish and Portuguese

Acknowledgments

First, I would like to thank Dr. John Grinstead for his continuous support and guidance throughout the last two years on this project. Additionally, I would like to thank our research team for their work in stimuli preparation and support: Laurie Maynell, Melissa Nieves-Rivera, Ana Laura Arrieta, and Pedro Ortiz-Ramírez. This project would not have been completed without your all your help and hard work.

This research was funded by the Undergraduate Research Scholarship (URS) from the College of Arts & Sciences Undergraduate Research Office. Additionally, this project received support from the LoAnn Crane Undergraduate Award for Hispanic Studies through the Department of Spanish and Portuguese. Lastly, this project was funded through a grant from the National Science Foundation (NSF-1551903).

Abstract

The main focus of this research project is to determine and compare English-speaking adults' understanding of quantity implicatures with regard to the phonetic factors of pitch and duration. We assume that there are at least four different varieties of the English word "some" in spoken language: one with the vowel deleted ("sm"), one with a full vowel and a low pitch relative to the noun it quantifies ("some"), one with a full vowel and a pitch roughly equal to that of the noun it quantifies ("sOme"), and one with a full vowel and a low+high* pitch accent ("SOME"), in the terms of Autosegmental Metrical Phonology. Previous research shows that the last option of *some* with a full vowel and pitch accent causes listeners to generate a "some but not all" interpretation, also known as generating an implicature. Through this research project, we are hoping to see what phonetic elements of this pitch accent, pitch or word/vowel duration, are relevant.

The phonetic factors that will be controlled in this experiment are the duration of vowels and words and the maximum pitch of the word *some*. To control for these factors, pre-recorded stimuli were used. We used PRAAT software to determine the consistency across settings of the pitch and duration of the quantifier (*some*) and the noun in the sentence. By analyzing the utterances, we also ensured that each condition was distinguishable by at least one phonetic factor.

Participants were shown videos in which less than four, or all four, characters complete an action. Participants were instructed to listen to what the narrator said about the story ("Some horses jumped over the fence," for example) and to accept or reject the narrator's sentence as a characterization of the video-recorded pragmatic context.

The results from the experiment show that implicatures were roughly generated to the same extent in all phonetic variant cases except for the reduced “sm” case. When the vowel was deleted, participants generated significantly less implicatures than in all other cases. This suggests that adult English speakers focus more on the duration of the vowel than on the pitch of the vowel in implicature generation. These results contradict our hypothesis and suggest that *sm* could be a distinct lexical item from the other phonetic variants of *some*.

Table of Contents

Acknowledgements....2

Abstract....3

Table of Contents....5

Chapter 1: Introduction....6

1.1 Existential Quantifiers in English....6

1.2 Adult Control Groups in Developmental Semantics-Pragmatics Research……...6

Chapter 2: Literature Review……...7

2.1 Scalar Implicatures....7

2.2 Child Studies of Quantifiers....9

2.3 Use of "some" in Implicature Generation....17

2.4 Implicature Generation in Spanish....20

2.5 Preface to Current Study....21

2.6 Summary……..23

2.7 Research Question……...23

Chapter 3: Methods…….……..…….24

3.1 Participants....24

3.2 Procedures....24

3.3 Materials....27

3.4 Results....35

Chapter 4: Discussion....38

Chapter 5: References....40

Appendices…….....42

Chapter 1: Introduction

1.1 Existential Quantifiers in English

Depending on how one pronounces it, the sentence "Some horses jumped over the fence." could mean "some, but not all of the horses we are considering jumped over the fence" or it could mean "some, and possibly all of the horses we are considering jumped over the fence." Previous research suggests that the phonetic form of the word *some* is important to which interpretation is chosen by the listener. If what one hears sounds more like *sm*, there is evidence that adult English-speakers tend to think it means "some, and possibly all horses", whereas if one hears something that has a full vowel and special change in pitch (called a "pitch accent"), then adult English-speakers tend to interpret it to mean "some, but not all" (Grinstead, Thorward, Ross & Maynell, 2010). In my project, we seek to determine whether the phonetic cues of duration and pitch equally affect English-speaking adults' interpretation of utterances. Specifically, the research question that we are attempting to answer from this project is as follows: "Which phonetic cues of quantifier-noun combinations in subject positions matter for the generation of implicatures?"

1.2 Adult Control Groups in Developmental Semantics-Pragmatics Research

Anyone who has tried to develop an experiment for working with children aspires to compare their behavior to categorical adult judgements of a set of stimuli. While this is straightforward with morphosyntax, e.g. "I have 2 dog." vs. "I have 2 dogs." - "Which one sounds better?", finding categorical judgements from adults for semantic and pragmatic phenomena can prove much more elusive. In my review of the literature, I will focus on adult judgements of existential quantifiers, such as *some*, and the degree to which studies have taken

into account the phonetic properties of their stimuli. The majority of studies of Quantity Implicatures associated with *some* have not taken phonetic properties into account. Perhaps most notably, the no-vowel phonetic variant of *some,* written as *sm* in early work by Postal (1964) and Milsark (1977), is not considered explicitly, though it may have been used unintentionally in these studies, despite having, what turn out to be, very specific interpretative properties.

Chapter 2: Literature Review

2.1: Scalar Implicatures

In his article "Logic and Conversation," H. P. Grice describes and defines many important linguistic ideas. He begins by explaining the idea that the symbols and meaning in formal logic do not always agree with the semantic meaning of the same words in spoken language. There is some element of spoken language that causes it to differ from the straightforward logical terms. Grice introduced the term "implicature" to describe the situation where the literal meaning of what one says does not equal the message the person wanted to get across. In other words, some type of inference has to be made by the listener about what the speaker meant, implied, or suggested.

There are various classifications of implicatures, including conventional and nonconventional implicatures. In a conventional implicature, the conventional meaning of whatever is said will implicate the intended meaning. Nonconventional implicatures are more complex, and Grice talks about a subset of nonconventional implicatures called conversational implicatures. Conversational implicatures are connected to elements of spoken language. Grice defines these elements of spoken language, assuming the truth of the Cooperation Principle, which states that one responds appropriately to the context of whatever a conversation is about.

The four elements that Grice highlights are quantity, quality, relation, and manner. The category of quantity implies that, to converse, a person must give sufficient information, but not more than is required. Quality, Grice argues, means that people do not say what they believe to be false and do not talk about things they do not know. Relation has to do with sentences being relevant information to a topic, and manner says that people avoid ambiguity, and keep utterances brief and orderly. In general, these principles guide how people converse. Implicatures are generated when one or more of these principles are not obeyed in communication.

Grice expands on the difference between conventional implicatures and conversational implicatures by noting that, in order to be classified as a conversational implicature, the hearer will interpret and respond to the following criteria: 1.) The conventional meaning of the words used and any references; 2.) The Cooperation Principle; 3.) The context of what was said; 4.) Other background knowledge; and 5.) The idea that both the speaker and listener are both aware of all criteria above.

Some examples of implicatures can be seen in literary elements like metaphors, hyperboles, irony, ambiguity, and meiosis, and many more. Any context in which the literal meaning of what is said does not match the intention of the speaker involves an implicature. Grice ends by proposing the features that conversational implicatures must have: 1.) The implicature must be able to be canceled in a certain context; 2.) The same thing cannot be said in another way that lacks the implicature (nondetachability); 3.) Conversational implicature are not included in the semantic meaning of the word; 4.) What matters is the "saying of what is said," not the actual words; and 5.) If there are more than one potential way to interpret the implicature, it can remain indeterminate (Grice, 1975).

Perhaps the best known of Grice's proposed conversational implicatures is the scalar Quantity Implicature. The Quantity Scale includes the quantifiers, ordered by quantity {all, most, many, some, few, none...}. Grice claims that when one uses a quantifier lower on the scale than *all*, the intended meaning will include the negation of *all*, as in "some, but not all". This follows again from the Cooperative Principle, which states that if the speaker had intended to convey the "some, and possibly all" interpretation, they would follow the Maxim of Quantity and simply have used *all*. To diverge from this Maxim would be uncooperative (Grice, 1975).

Significant work in our understanding of adult use of quantifiers and their interpretations has come from studies of children's interpretations of quantifiers, by virtue of having to compare their interpretations to those of adults. In this project, we will concentrate on the judgments of adult native speakers of English, with an eye towards future work measuring what children know.

2.2: Child Studies of Quantifiers

In 1980, Carol Smith designed and performed an experiment regarding how children respond to questions involving quantifiers, specifically *all*, *some*, and *none*. Previous research shows that young children know the meanings of these words, but still have trouble answering certain types of questions involving quantifiers. In order to distinguish which situations are harder for children to correctly identify the meaning of the quantifier, the questions were split into two distinctions: property and category. The property questions used quantifiers to ask participants about a property of something of general knowledge. For example, "Do all elephants have trunks?" belongs to the category of all-property. The category questions would ask if a

certain word belonged to a group. For example, “Are some dogs animals?” would be considered a some-category question.

In the experiment, sixty children were tested by receiving a series of questions that had property and category distinctions with a quantifier. Their response was measured as either “yes” or “no.” The children’s results were compared to adult model behavior. Adults were not explicitly tested in this experiment. Rather, the “adult-like” category of children responses was based off “presupposed” models of adult responses. The results of the study showed that children use syntactic information to interpret the meaning of a question, as 87% of children had adult-like responses to all-category questions. However, when the question set was after a some-category set, the correct responses were much lower. Also, when the question was on the second half of the list, the percentage of correct responses decreased. There are explanations for why children deviated from adult-like patterns in these cases. First, they could have mistakenly placed the quantifier with the wrong noun. Another possible explanation for the deviation is that the children ignored the force of *all* when listening to the question. The strategies that children used to incorrectly join the quantifier and noun are unknown and need to be researched further.

In all other situations, including all-property, some-property, and some-category, children responded correctly in almost all cases. This shows that children use syntactic cues to understand the meaning of the question. These results were not affected by their placement in a sequence or what tests were before or after them.

Because a similar correct response percentage was generated for *all* and *some* questions, the results show that interpreting *some* is not more difficult than interpreting *all*, which disproves a previous hypothesis. There is no evidence that suggests there is any different methods for interpreting these two words. The results also show that children use syntactic cues to interpret

quantifiers in certain situations. More research needs to be done to figure out methods for how children interpret and answer questions that contain quantifiers (Smith, 1980).

Critically, Smith used individual level predicates, in the sense of Carlson (1977), such as "Some giraffes have long necks." and "Some dogs are animals." to test what children knew about the properties of the quantifiers, including "some". These predicates are known to be incompatible with the phonetically weak version of "some", written *sm*, which introduces a group referent (Milsark 1977, Gutiérrez-Rexach 2001, 2010). Thus, though recorded stimuli were not used, it seems unlikely that *sm* was the phonetic version of *some* that the investigators used. Second, the stimuli were presented in yes-no, polar questions, which are considered to be "downward-entailing contexts" (Stalnaker 1979) in the sense that they reverse entailment patterns, and cancel implicatures. In this way, it is unsurprising that children accepted, or answered "yes" to questions such as "Do some giraffes have long necks?" in large percentages (see Figure 1, from Smith 1980, p. 196), inasmuch as they were interpreting *some* to mean "some, and possibly all" – its truth-conditional meaning.

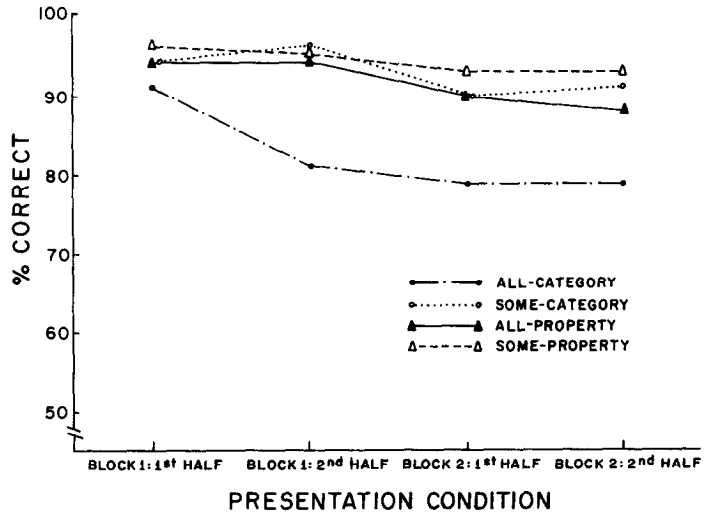

FIG. 1. Percentage correct on the four types of questions for the different presentation conditions (N = 30 in each presentation condition). Note: the children in Block 1 on the all-questions are in Block 2 on the some-questions; children in Block 2 on the all-questions are in Block 1 on the some-questions.

Figure 1: Percent Correct Interpretation from Smith (1980, p. 196, Figure 1)

It is important to note that this study performed by Smith did not test adult subjects. Rather, it relied on presupposed knowledge on how they would respond in each context (Smith, 1980).

The work done by Ira Noveck combines the two concepts outlined above to attempt to show that children are capable of generating an implicature based on the quantifiers used and tone of the speaker. In his article "When children are more logical than adults: experimental investigations of scalar implicature," Ira Noveck describes his project involving scalar implicatures as defined by Paul Grice. The first goal of Noveck's study was to establish that scalar implicatures exist and are common in normal interpretation of speech. The other goal of the study was to determine how and when weak scalar terms (some) are developed. To do this, Noveck designed and executed three experiments. The first was a task in which a puppet described a scenario regarding which objects could be in a box that was not visible. Then, participants had to say whether or not the puppet was correct. The target sentence was one that had the word 'might' in it, as this is the case that may or may not generate an implicature. Both children and adult controls were tested in this experiment. The results show that children have a more logical interpretation of the utterance rather than the adult-like pragmatic interpretation. Noveck concluded that children may not have the cognitive ability to generate implicatures.

The second experiment was designed to have the same components as the first but happened after the participant was trained on the situation. Noveck hypothesized that after training, participants would have more of a logical approach with their responses. The results from the experiment support his hypothesis, but adults still produced less logical responses than the children did. This further supported Noveck's claim that age played a role in the ability to generate implicatures.

The third experiment uses the French quantifier ‘certains’ (some) and was administered using a double-blind method to native French speakers. The design of this experiment causes responses to be made based on working memory knowledge and implicature generation. The results again showed that children were not as proficient as adults in recognizing conditions where a pragmatic interpretation (“some but not all”) should be used over a logical interpretation (“some and possibly all).

This study by Noveck was conducted in a way that relied on participants’ knowledge of the world and relied heavily on working memory. This was the case because the predicates that Noveck used were of the Individual Level type (in the sense of Carlson 1977) in that they denoted properties or inherent characteristics, such as “Some giraffes **have long necks.**” Therefore, the conclusion that children are unable to generate implicatures in the same way that adults do must be questioned because knowing whether and when it is acceptable to agree that all giraffes have long necks is a function of one’s specific context in the world (e.g. the stuffed giraffe on my bed, a baby giraffe compared to an adult giraffe, etc.). Because world knowledge and working memory were vital to performing well, the experiments in this study were not designed well to measure children’s ability to simply generate implicatures (Noveck, 2001). A follow up study was done by Pouscoulous, Noveck, Politzer & Bastide (2007) in an attempt to validate the claims made by Noveck in 2001.

The first experiment in Pouscoulous’ study was similar to the first experiment by Noveck in 2001, but it was developed in a way that world knowledge was not needed to succeed. Specifically, this study used activity predicates that referred to events being played out in front of the participant. Thus, everything needed to successfully answer any questions could be seen by the participant in front of him or her. Also, a negative use of a quantifier was used in this

experiment. For example, “Some giraffes are not in the box.” This was found to be a harder context in which to interpret the quantifier. The results from the first experiment validate the results found from Noveck. Children responded to the stimuli in a more logical manner than adults did, meaning adults still generated implicatures.

The second experiment in Pouscoulous’ study was meant to prove that children have the ability to generate implicatures. The researchers simplified the scene by taking out distractors and only focusing on objects inside the box and used a simpler French quantifier that children understand better. The results did show an increase in pragmatic interpretations from children. This suggests that children are capable of generating implicatures.

The third experiment done by Pouscoulous et al. was designed to connect the results from the first two studies. Two French quantifiers (‘certains’ and ‘quelques’) were present in the situations. The adults tested showed no difference in response no matter which quantifier was used. Therefore, they generated implicatures in both cases and responded pragmatically in both cases. Children responded pragmatically in the cases with ‘quelques’ but more logically to sentences with ‘certains.’ Therefore, Pouscoulous et al. concluded that children do not have the same level of cognitive resources to generate implicatures that adults do (2007).

Overall, Pouscoulous et al. (2007) showed the negative effects of memory and distractors on linguistic processing in children. The study helped explain many results that were found by Noveck in 2001. Pouscoulous et al. showed that children were able to correctly generate implicatures in some contexts. However, in other contexts, children did not have adult-like responses. Together, these studies show that generating implicatures can be affected by word complexity and context. After a certain point, cognitive ability is key in the generation of implicatures. However, these two studies do not take into account the factor of vowel duration or

pitch of quantifiers and nouns. We believe that these two factors are very important of interpretations of quantifiers in English (Pouscoulous et al., 2007).

The article "Why children and adults sometimes (but not always) compute implicatures" by Guasti et al. (2005) presents four experiments that respond to the findings in Noveck (2001) and Papafragou and Musolino (2003). The goal of their research was to determine what factors limit children's ability to generate implicatures. They hypothesized two different suggestions as to why this could happen: first, the Pragmatic Delay hypothesis. This predicts that children cannot generate implicatures because they do not have the same cognitive ability as adults to understand pragmatic cues. The second hypothesis the authors suggested is the Pragmatic Limitation hypothesis, which says that children can generate implicatures, but not to the same extent that adults can. In certain contexts where children are given sufficient information, they will be able to perform as adults do. The four experiments were designed to test these hypotheses and replicate the findings of Noveck, Papafragou, and Musolino.

The first experiment was nearly identical to the study done by Noveck in 2001 regarding uses of quantifiers in a statement evaluation task. The study was performed on Italian speakers and conducted in a similar manner to Noveck, where statements were read such as "some giraffes have long necks" and the participant evaluated the statement as true or false. The results from the first experiment supported the conclusions of Noveck that children processed things more logically and adults more pragmatically. This was seen by children's acceptance of "some" when adults rejected it because "all" was more appropriate.

The second experiment in the study was similar to the experiment that Papafragou and Musolino performed in 2003. The participants were given a training so that they understood the context of the experiment better. As expected, children had adult-like responses to the same

sentences after they were given the training. This experiment reinforced the conclusions of Papafragou and Musolino that children have the ability to generate implicatures. The results of this study provoked two questions to the experimenters: first, if the training that influenced the participants had a lasting impact. The third experiment was designed to test this possibility. The second question asked for an explanation why the training helped some participants but not others. The fourth experiment was designed to attempt to explain what specific factors were helpful for the children to generate implicatures to answer this question.

As mentioned, the third experiment was similar to the second experiment, as participants received training prior to the test phase. One week later, the participants were tested again without the training. The goal of this experiment was to determine whether or not the effects of the training were long lasting. The results from the experiment suggest that they are not long lasting, as children failed to generate implicatures again. This suggested to the experimenters that something else had to influence children's generation of implicatures. The second experiment proved that they have the ability to generate implicatures, but the third experiment showed that despite successfully doing it one time, it was not a consistent behavior.

The fourth experiment was designed as a Truth Value Judgement Task. In contrast to the Noveck-type stimuli, which consisted of individual-level predicates like *Some giraffes have long necks.*, the experiment 4 stimuli consisted of activity predicates such as *Some monkeys are eating a biscuit.*, in which the situation denoted by the predicate is supported by the action illustrated in the TVJT. A video stimulus was presented to fifteen 7-year-old Italian-speaking children and to 12 adult Italian speakers, presenting a situation. At the end of the situation, or Truth Value Judgment Scenario, a yes-no question was asked, which the participants had to affirm or reject. This prevented any lack of encyclopedic knowledge to interfere with pragmatic interpretations.

Each participant had the same information to make a judgement from. The results from the study showed that children generated implicatures at nearly the same rate as adults. These results showed that context plays a role in the generation of implicatures. We also infer that the use of individual-level predicates in Noveck's work was problematic, as recognized in Pouscoulous et al. (2007), below. Because this work was done in Italian (though the stimuli in Italian are not given in the appendix), the issue of the phonetic properties of the existential quantifier seems less critical, though this is hard to evaluate as the actual Italian quantifiers-bearing sentences are not given (Guasti, 2005).

2.3: Use of "some" in Implicature Generation

A 2004 paper by Papafragou and Tantalou is one of the few papers that specifically mentions contrastive stress as it relates to implicature generation. It is focused on the idea that an implicature can be generated from *some*, meaning "some, but not all." The experiment was performed on thirty Greek-speaking children. There were three different cases of scalar implicatures that were designed to represent implicatures that adults generate in everyday contexts. First was the quantificational condition, which used words on the quantity scale (some, all, etc.). The encyclopedic condition used worldly knowledge in addition to interpreting the sentence to generate an implicature. Lastly, the ad hoc condition relied on circumstantial evidence. These situations were meant to be "real-world" examples of how adults generate implicatures.

For the most part, children were able to generate implicatures in all three contexts. They were also able to explain why in most cases. This was because the weaker words used implied that the stronger word was not true, i.e. an implicature was generated. The authors of this paper

suppose that the contrast between words in implicature generation is an essential part of language acquisition, which is why children are able to generate implicatures in these contexts (Papafragou and Tantalou, 2004). This article does not specifically mention how the stress placed on different words might affect responses, but it mentions the contrast between using "all" and using "some" to convey different meanings. It also does not specifically test adults, but recognizes that adults are able to generate implicatures in contexts that involve the quantity scale.

In 2005, Miller, Schmitt, Chang, and Munn at Michigan State University designed an experiment to determine whether English-speaking children were able to calculate scalar implicatures involving the word *some* or not. As previous research concluded that children had difficulty with this task, the study also tested if the tasks given to children could account for their inability to calculate implicatures. To do this, two experiments were designed and implemented. The first used a Direct Instruction Task, which tested comprehension of *some* in presuppositional versus non-presuppositional phrases. A subject or phrase is considered to be presuppositional when some knowledge is assumed prior to the sentence utterance. For example, the verb "make" can either be a verb of creation or a verb of change of state. When used in a context where "make" takes a clause after instead of a direct object, it is used as a change of state verb and there is an existence presupposition associated with it.

The first experiment of this study tested children's comprehension of the word *some* in varying contexts as mentioned above. A Direct Instruction Task was used, and the participants were asked to draw happy faces on images printed without mouths based on what they heard. There were three target conditions: the unstressed some/presuppositional case ("Make some faces HAPPY"); the stressed some/presuppositional case ("Make SOME faces happy"); and the

unstressed some/non-presuppositional case ("Make some HAPPY faces"). The results from Experiment 1 show that children were able to distinguish between the presuppositional and non-presuppositional cases, as they completed the task differently in these two cases. Both children and adults inferred that the non-presuppositional sentence does not have an implicature. In the case of the stressed *some*, children were able to correctly generate the scalar implicature. Also, the results show that children were sensitive to contrastive stress, which helped them generate implicatures in these cases.

The second experiment was designed to show that the Direct Instruction Task from Experiment 1 did not produce the results due to the nature of the test. To do this, researchers designed a Picture Matching Task where participants had to respond to two different conditions: the unstressed *some* ("Show me where Pete made some faces HAPPY") and the stressed *some* ("Show me where Pete made SOME faces happy"). A puppet named Pete drew smiles on either zero, three, or four of four faces on a paper and the sentences were read. Then, participants had to decide which situations were correct based on what Pete said. If only the picture with three of four faces drawn was selected (some, but not all), an implicature was generated. The results show that children differentiated between the stressed and unstressed *some*. This meant that the children were able to pick up on pragmatic cues from speech that helped them to make this decision. The results from this study contradicted previous research that suggested that children have a delay in pragmatic development and thus would not be able to complete these tasks with the accuracy they did. This study was also one of the few studies done that mentions contrastive stress specifically. Depending on which word of the sentence was stressed or accented, different responses were calculated (Miller, 2005).

2.4: Implicature Generation in Spanish

In the study entitled "Context and the Scalar Implicatures of Indefinites in Child Spanish," children's generation of implicature with the Spanish word *algunos* ("some") and lexical meaning shifts of *unos* ("some") were measured in different contexts. Previous research showed how implicatures are generated with the word "algunos," causing a "some-but-not-all" meaning, but not in the word "unos." The first experiment of this study involved twenty-seven monolingual Spanish-speaking children (mean age five years and nine months) and ten monolingual Spanish-speaking adults, all from Mexico City. The participants were given a Truth Value Judgement Task to determine if sentences involving "unos" and "algunos" were correct in response to a live Truth-Value Judgment Task, in which a number of animals jumped/did not jump over a fence. The results showed no significant difference in generating a "some-but-not-all" pragmatic implicature with "algunos" between child participants and adults. This contrasts with previous findings on the topic, which showed a delay in the understanding of pragmatic implicatures. The other significant finding from this experiment was that children successfully distinguish the words "unos" and "algunos" at a young age. This shows that children are able to calculate alternative sets associated with the word "unos" with the same results as adults.

The second experiment used the same participants and a Truth Value Judgement Task, but the target words of "unos" and "algunos" were used in downward-entailing contexts. The purpose of this was to see whether or not children were able to cancel implicatures related to the word "algunos" in these contexts as adults do. The results show that children successfully cancel the implicatures at the same level adults do. When "unos" was placed in a downward-entailing environment, the children also correctly identified that the lexical properties and meaning remained the same.

The success of the children's ability to generate and cancel implicatures of "algunos" and recognize the lexical properties of "unos" indicates that Spanish speaking children develop pragmatics and syntax-semantics skills around the same time. This rejects previous research that suggested a delay in pragmatic development in the cases involving implicatures (Noveck, 2001). The results also indicate there is a part of language acquisition that is innate, as nobody is taught what a downward-entailing context is. Using the principles of generalizability, a type of domain-general learning system, children would have incorrectly generated implicatures for "unos" or labeled "algunos" as being correct differently than they did. However, the results show children's ability to make subtle language decisions at a young age, and more research is needed to show how this ability is related to language (Vargas-Tokuda, 2009).

2.5: Preface to the Current Study

The study performed by Grinstead, Thorward, Ross, & Maynell (2010) systematically controlled phonetic properties of the quantifier *some* to determine the important property, vowel duration or pitch, for calculating or canceling implicatures. The study assumes three different forms of the word *some*. One is with full vowel with a high pitch accent, that is usually associated with a pragmatic implicature, meaning "some, but not all." Another version of the word has a deleted vowel [sm]. This is often associated with being purely existential, meaning "some and possibly all." Lastly, there is a version in the middle of the two previously mentioned, with a full vowel but without a pitch accent. This version is also often associated with the purely existential meaning "some and possibly all."

The study measured the degree to which both children and adults determine to interpret the implicature or non-implicature version of *some* based on syntactic-semantic context, vowel

duration, and pitch accent. To do this, a between-subjects study design was followed with three groups of 30 adults and 3 groups of 24 children hearing only one variant of *some*. A video was shown to each subject in which a number of animals jump over the fence, then a voice says something like "some/none/all of the animals jumped over the fence." The task of the child or adult is to say whether the person narrating was correct or incorrect. The variables controlled for in this experiment were word duration, vowel duration, and maximum pitch. There were significant differences between the maximum pitch in the pitch accented full-vowel "SOME" and the deleted vowel "sm," between the vowel duration in the pitch accented full-vowel "SOME" and full vowel "some," and between the word duration in the full vowel "some" and the deleted vowel "sm."

Based on the results of the study, it was seen that adults rely heavily on the presence of the pitch accent in generating an implicature, interpreting the full vowel "some" as "some, but not all." They do not rely heavily on vowel realization. This was proven because they interpreted the middle full vowel "some" as more closely related to the deleted vowel case "sm" as to "SOME," the pitch accented case. The phonetic element of the words that was different in "some" and "SOME" was the pitch accent, which demonstrates that adults rely on the pitch accent to develop an implicature. However, prosodic cues such as the pitch accent do not override the syntactic-semantic context. This was seen through the downward entailing contexts, when the implicature was cancelled by most adults. Children, on the other hand, rely more on the vowel realization than on the pitch accent. This can be seen through the fact that kids related the full vowel case "some" more similarly to the pitch accented case "SOME" over the deleted vowel case "sm." More work is needed to determine how children cancel the implicature in downward-entailing contexts (Grinstead, 2010).

2.6: Summary

As seen through the literature review, the previous research on the topic acknowledges the fact that both children and adults are able to cancel implicatures. Previous research also suggests that adults focus more heavily on the pitch accent than on the vowel duration when determining whether or not to cancel an implicature (Grinstead, 2010). However, a fourth version of *some* appears to occur in natural speech. Therefore, the current study uses four phonetic variants of the word *some*: one with the vowel deleted ("sm"), one with a full vowel and a low pitch relative to the noun it quantifies ("some"), one with a full vowel and a pitch roughly equal to that of the noun it quantifies ("sOme"), and one with a full vowel and a low+high* pitch accent ("SOME"). Each of these four phonetic variants of *some* differ in at least one of the following: Quantifier word length, quantifier vowel length, quantifier maximum F0, noun maximum F0, and/or the difference between the quantifier maximum F0 and the maximum noun F0.

Based on what participants respond, we are able to determine whether they focus on the pitch or vowel duration when determining whether or not to generate an implicature for the word *some*.

2.7: Research Question

When considering four different cases of the word *some*: One with the vowel deleted, one with a full vowel and a low pitch relative to the noun it quantifies, one with a full vowel and a pitch roughly equal to that of the noun it quantifies ("sOme"), and one with a full vowel and a low+high* pitch accent ("SOME"); do adult English speakers focus more on the pitch or vowel/word duration of *some* in determining whether or not to generate an implicature?

Chapter 3: Methods

3.1: Participants

The study was conducted on 33 typical, English-speaking adults in Columbus, Ohio. The mean age was 245.4 months with a standard deviation of 15.2 and an age range of 221-269 months.

3.2: Procedures

To participate in the study, participants completed three executive function tasks on Examiner which is run on PsychoPy. First, the Flanker task measured inhibition. The Set Shifting task measured attention. Finally, the Dot Counting task measured working memory. Each of these tasks were scored. A summary of the scores can be found in the appendix.

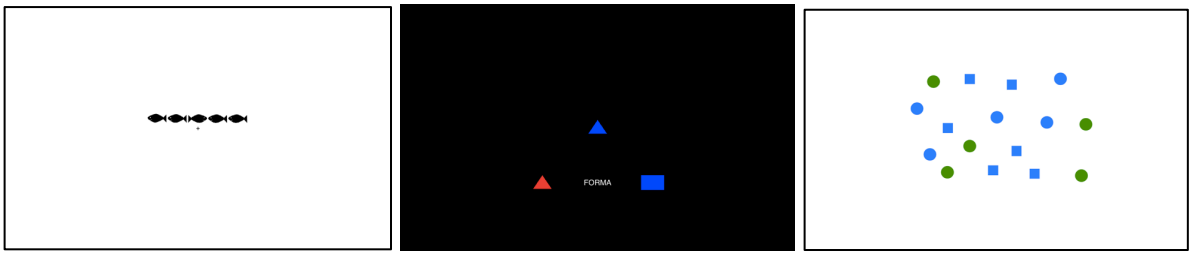

Figure 2: Flanker, Set Shifting, and Dot Counting Tasks (Respectively)

Once the executive function tasks were completed, the participants were asked to watch a series of narrated Claymation videos. Every participant watched the same four warmup videos. In the warmups, either 0 of 4, 2 of 4, or 4 of 4 agents completed the activity of crossing a bridge. The video of the agents crossing the bridge was narrated. The narration ended with the target sentence that either said “I know! All the kids crossed the bridge,” or “I know! No kids crossed the bridge.” The participant had to note whether the target sentence was true or false based on what happened in the video. Therefore, there were correct and incorrect answers for the warmup exercises.

For the experimental items, participants were split between four groups in a between-subjects design. Each group corresponded with a phonetic variant of *some* that only that group heard. Therefore, each group heard one and only one phonetic variant of *some*. The first group heard the full vowel accented "sOme." The second group heard the variant with the deleted vowel, "sm." The third group heard the low + high* pitch accented "SOME," and the fourth group heard the full vowel, unaccented "some." These versions of *some* were used in the target sentences at the end of the scenario similar to the warmup exercises.

There were five experimental scenarios. Each participant saw each scenario two separate times. One time, 3 of 4 agents completed an activity. The other time, 4 of 4 agents completed the activity. In Figure 3 below, a screenshot of the experimental item can be seen. It shows the Claymation video where 4 of 4 children went down the slide.

Figure 3: Screenshot of experimental scenario

The following is an example of the audio narration one would hear while watching the Claymation video:

"The kids are home. They want to go upstairs and watch tv. Oh no! The ladder is really

tall. Who will climb the ladder? I know! Some kids climbed the ladder." A full list of target sentences can be found in the appendix.

The target utterance is at the end: "I know! Some kids climbed the ladder." Based on what participants saw, they needed to determine if that sentence was true or false. Again, each target sentence had the same phonetic variant of *some* for the participant.

To create the audio stimuli, Laurie Maynell, a trained phonetician, recorded utterances in a sound booth. I used PRAAT to measure the vowel duration of *some*, the maximum F0 of the quantifier *some*, and the maximum F0 of the noun *kids*. I then used SPSS Statistics to determine that each phonetic variant of *some* was statistically distinct from one another in vowel duration, word duration and/or maximum F0. I also ensured that within the phonetic variants, there was consistency and no statistical outliers. I reported to Laurie on which stimuli needed to be re-recorded. She then re-recorded and I re-measured until there were no statistical outliers within each group and each phonetic variant was different from all the other phonetic variants in at least one way.

Once the stimuli were recorded, iMovie was used to pair the recorded audio files with clay animation video clips. Once this was done, the audio file was put back into PRAAT to measure the time of the first /s/ sound to calculate the reaction time.

Along with the experimental items, filler sentences and warm-ups were used. For warmups, there was a scenario where kids were crossing a bridge. Then, the voice in the background would say something like "I know, all the kids crossed the bridge." By using words "all" or "none," both warmups and fillers had clear correct and incorrect answers. The point of the warmups was to get the participant accustomed to the task. The fillers were used to filter out

participants who were not paying attention. A full list of warmup and filler sentences can be found in the appendix.

The videos were shown through SuperLab 5 on a 2015 MacBook Pro with Retina Display. Each participant wore a pair of noise-cancelling Sony over-the-ear headphones.

3.3: Materials

To prepare the stimuli, Laurie Maynell, a collaborator who is a trained phonetician recorded the various utterances in a sound booth. The goal during initial recording was to get the various sentences in each version of some across the 5 different experimental scenarios to have values as close to each other as possible, while still sounding like natural speech. The first phonetic variant of *some* is the reduced form, with a completely deleted vowel: "Sm." Next is the "some – deaccented" case. This phonetic variant has a full vowel and no pitch accent on *some*. The pitch of *some* is lower than the pitch of the noun following. Third is the "some – accented" case. This phonetic variant has a pitch on the word *some* and a full vowel. The pitch of *some* roughly matches the pitch of the noun that follows. Lastly, the "pitch accented some" has a unique pitch contour. Below, I have included photos of each case in PRAAT to display the differences between each in Figures 4-7. Each of the PRAAT screenshots shown are for the target sentence of "Some kids went around the bus." The first two markings on each photo show the F0 of the quantifier (labeled "deacc," "L+H*", "red," and "H*q" for deaccented, pitch accented, reduced, and accented, respectively) and the F0 of the noun. Below that, the length of the word "some" in each case was measured. Lastly, the length of the vowel is seen by the notation of "v" in each case. Table 1 below summarizes the final audio stimuli data in each target sentence.

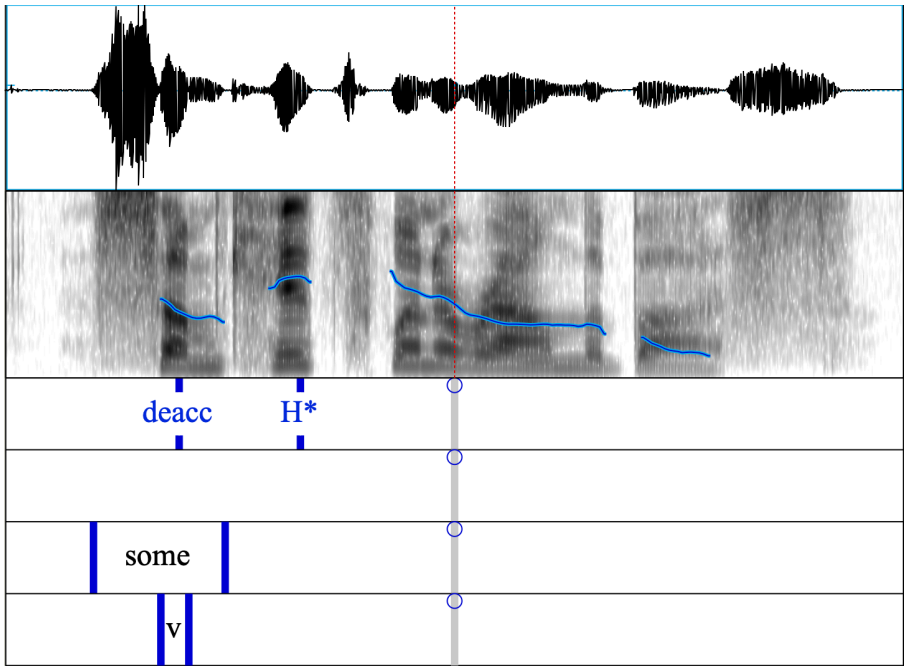

Figure 4: PRAAT data for the full vowel deaccented "some" variant

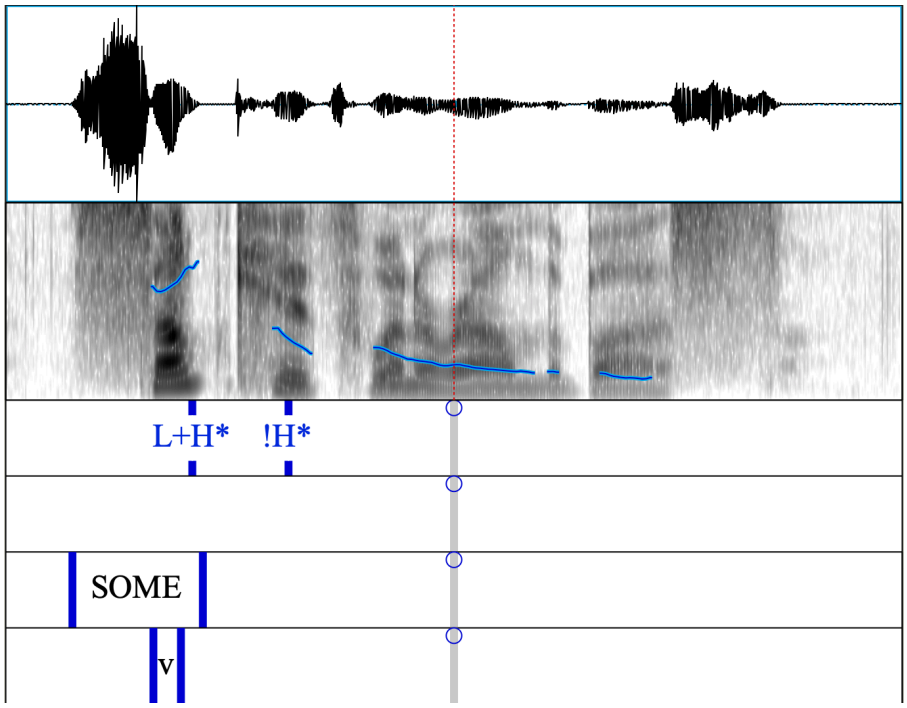

Figure 5: PRAAT data for pitch accented "SOME" variant

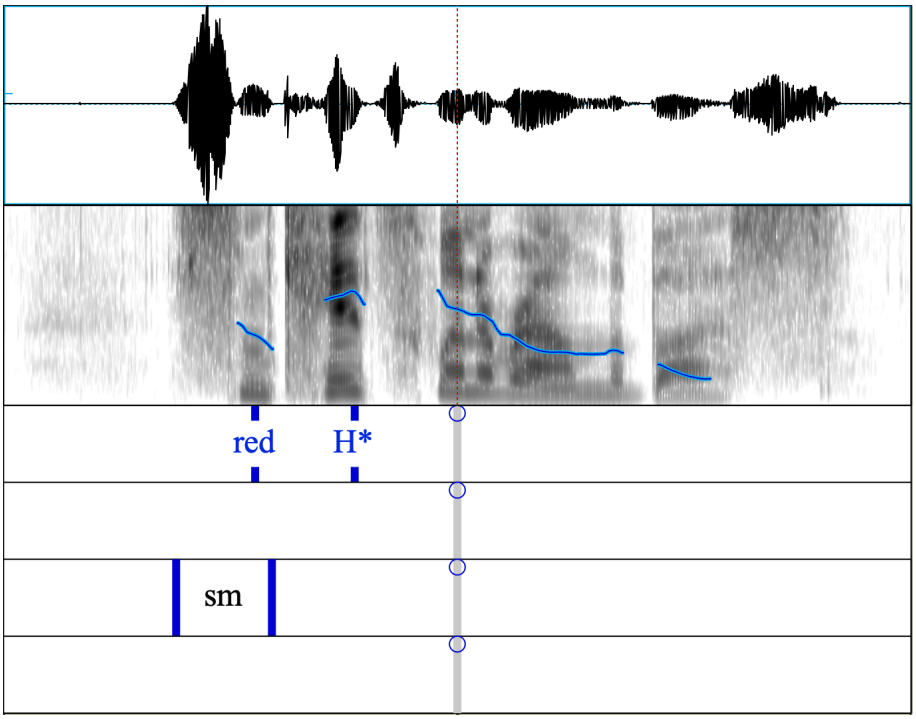

Figure 6: PRAAT data for reduced variant

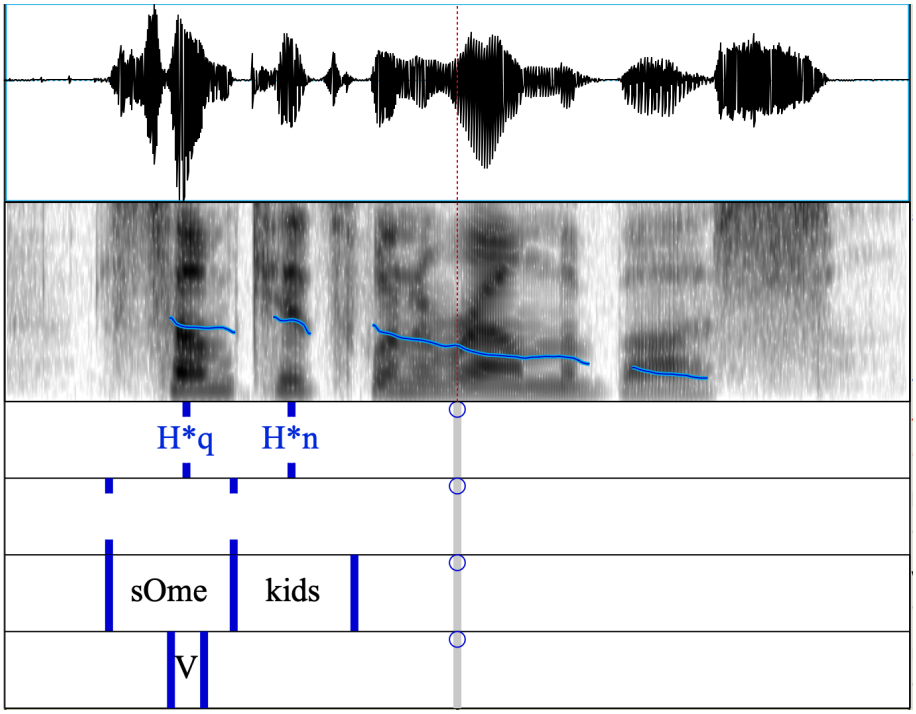

Figure 7: PRAAT data for the full vowel accented variant ("sOme")

I used PRAAT software with each sentence to determine the word length, the vowel length (if applicable), the quantifier maximum pitch, and the noun maximum pitch. I measured and recorded these values and calculated the difference in pitch between the quantifier and noun, which are given in the Table 1 below.

Item	*Some* variant	Quantifier Word Length (sec)	Quantifier Vowel Length (sec)	Quantifier Maximum F0	Noun Maximum F0	Difference between Quantifier and Noun F0
1	sm	0.2298	0.0000	229.2143	316.2640	87.0497
2	sm	0.2041	0.0000	237.1901	307.2835	70.0934
3	sm	0.2182	0.0000	233.0148	316.3041	83.2893
4	sm	0.2308	0.0000	237.0484	304.1953	67.1469
5	sm	0.2203	0.0000	232.0320	296.7954	64.7633
1	some - deaccented	0.2689	0.0616	234.4554	254.2335	19.7780
2	some - deaccented	0.2827	0.0600	236.4112	257.2646	20.8534
3	some - deaccented	0.2786	0.0639	239.2883	251.4792	12.1908
4	some - deaccented	0.2680	0.0657	244.0870	258.6222	14.5353
5	some - deaccented	0.2841	0.0658	244.5142	248.7546	4.2404
1	some - accented	0.3037	0.0645	232.7820	305.1850	72.4029
2	some - accented	0.2902	0.0643	224.6396	291.4257	66.7861
3	some - accented	0.3015	0.0674	229.4586	305.2635	75.8049
4	some - accented	0.2813	0.0606	224.0825	288.2608	64.1783
5	some - accented	0.3035	0.0690	228.4089	292.8397	64.4308
1	some – pitch-accented	0.3227	0.0680	369.6516	206.9885	-162.6631
2	some – pitch-accented	0.3373	0.0698	376.3208	223.0645	-153.2564
3	some – pitch-accented	0.3180	0.0720	416.7447	213.2285	-203.5162
4	some – pitch-accented	0.3327	0.0689	409.7815	204.1055	-205.6760
5	some – pitch-accented	0.3554	0.0706	394.6066	219.8773	-174.7293

Table 1: Phonetic Values of Stimuli

The final column was calculated by subtracting the value of "Noun F0" from "Quantifier F0". We ran statistics on the stimuli to determine which original recordings were statistically insignificant and therefore needed to be re-recorded. After re-recording until values were appropriate so that all versions of reduced, accented, L+H*, and deaccented cases were statistically similar with no outliers, we paired the audio stimuli with the video recordings. A summary of each of the following: Quantifier word length, quantifier vowel length, quantifier max F0, noun max F0, and difference between quantifier and noun F0 are shown in the following Figures 8-12 for each phonetic variant of *some*.

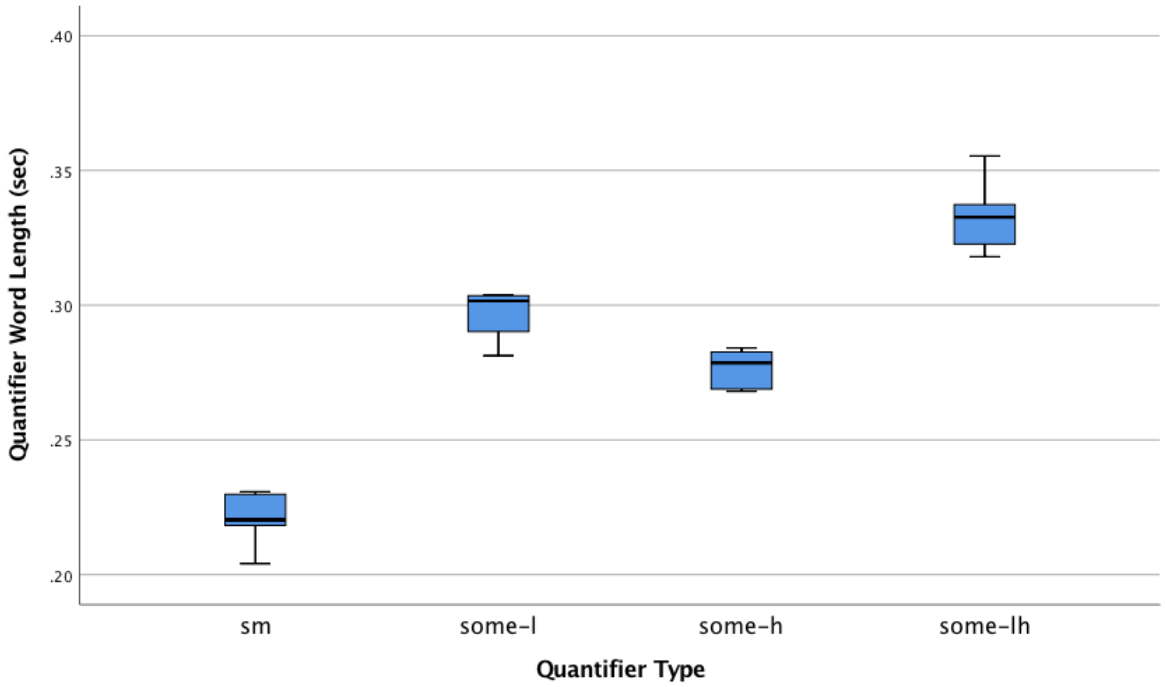

Figure 8: Quantifier word length for each phonetic variant

For Quantifier Word Length, as we see in Figure 8, there were significant differences among the stimuli ($f(3,16) = 90.679$, $p < .001$) and each stimulus was different from all others ($p < .05$).

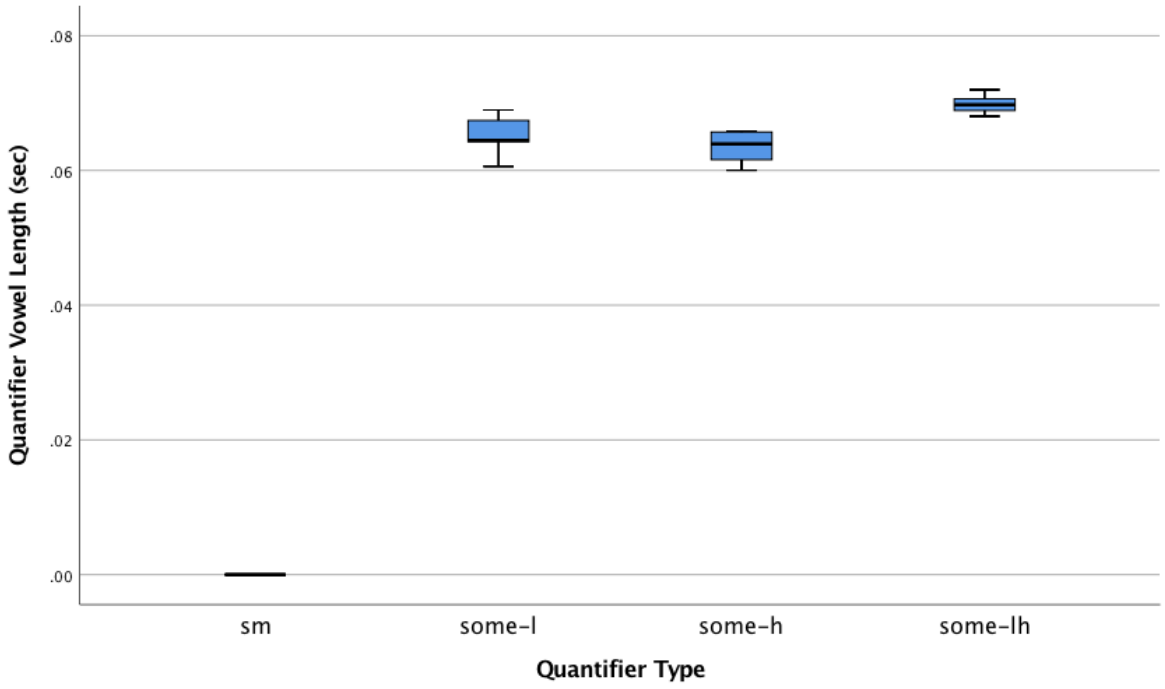

Figure 9: Quantifier vowel length for each phonetic variant

For Quantifier Vowel Length, as we see in Figure 9, there were significant differences among the stimuli ($f(3,16) = 1142.845$, $p < .001$). The pitch accented L+H* and the reduced vowel "sm" forms were different from all other phonetic variants ($p < .05$). The unaccented some-l was different from all phonetic variants except the accented some-h and some-h was different from all phonetic variants except for the unaccented some-l ($p < .05$).

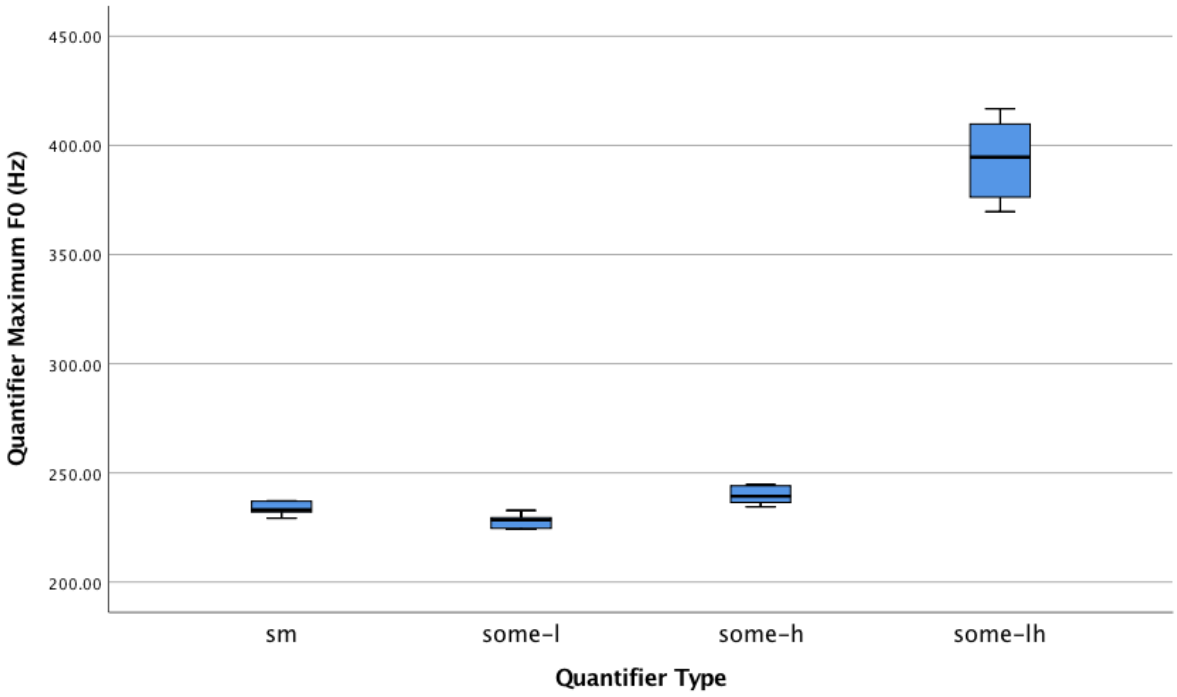

Figure 10: Quantifier maximum F0 for each phonetic variant

For Quantifier Maximum F0, as seen in Figure 10 above, there are significant differences among the stimuli ($f(3, 16) = 276.571$, $p < .001$). The pitch accented L+H* "some" was different from the rest of the phonetic variants of some ($p < .05$). None of the other phonetic variants showed significant differences with one another ($p > .05$).

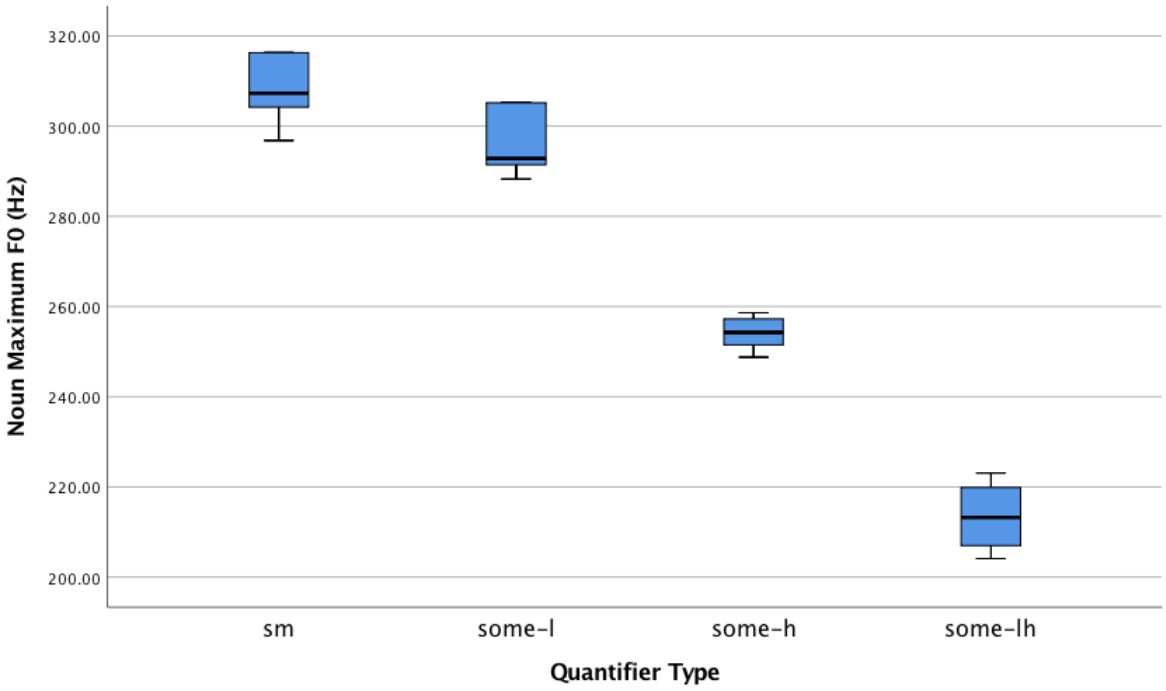

Figure 11: Noun maximum F0 for each phonetic variant

For Noun Maximum F0, as we see in Figure 11, there were significant differences among the stimuli ($f(3,16) = 172.528$, $p < .001$) and each stimulus was different from all others ($p < .05$).

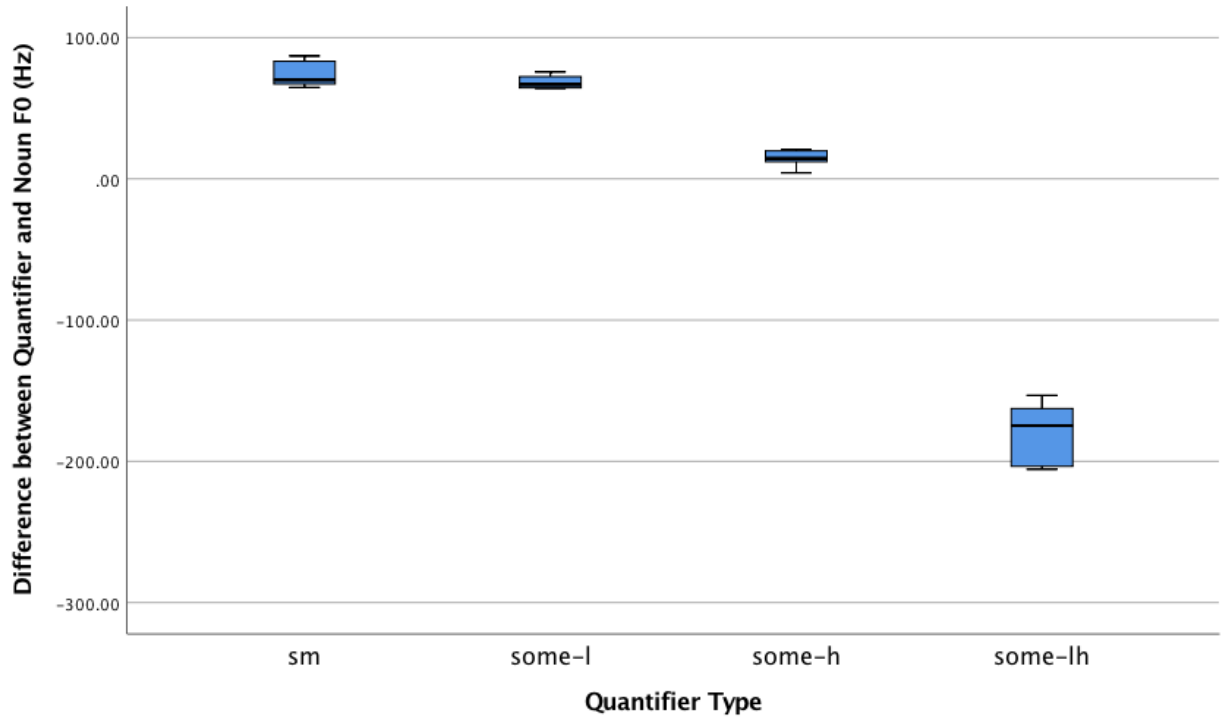

Figure 12: Difference between quantifier maximum F0 and noun maximum F0 for each phonetic variant

For the Difference between Quantifier and Noun F0, as seen in Figure 12, there were significant differences among the stimuli ($f(3,16) = 387.092$, $p < .001$). All phonetic forms were different from each other ($p < .05$) with the exception of the reduced "sm" and the unaccented some-l ($p > .05$).

3.4: Results

The results were gathered from the Excel table from the SuperLab experiment. They show the participant response (true or false) and response time in milliseconds for each warmup, experimental item, and filler item. In order to answer the research question, the experimental items were split into two categories: The stimuli where 3 of 4 agents completed the activity, and the stimuli where 4 of 4 agents completed the activity. Note that three outliers were removed by Tukey's Hinges, and therefore the reported data come from a sample size of 30 participants.

In the cases where 3 of 4 agents completed the activity, participants accepted all phonetic variants of *some* 162 of 165 times. For the cases where 4 of 4 agents completed the activity, the data is broken down by each phonetic variant. The breakdown of participants in each category is as follows: 9 participants for the accented, full vowel "sOme" condition, 8 participants for the deleted vowel "sm" condition, 8 participants for the full vowel, unaccented "some" condition, and 8 participants for the L+H* pitch accented "SOME" condition. Table 2 below shows the total acceptance of *some* in each phonetic variant in both 3 of 4 and 4 of 4 cases.

Phonetic Variant	Total Acceptance of some in 3 of 4 cases	Percentage of acceptance of some in 3 of 4 cases	Total Acceptance of some in 4 of 4 cases	Percentage of acceptance of some in 4 of 4 cases
Deleted vowel "sm"	40 of 40	100%	32 of 40	80%
Full vowel, unaccented "some"	40 of 40	100%	13 of 40	32.5%
Full vowel, accented "sOme"	43 of 45	95.5%	10 of 45	22.2%
L+H* pitch accented "SOME"	39 of 40	97.5%	11 of 40	27.5%

Table 2: Participant responses by phonetic variant and condition

Figure 13 below summarizes the mean acceptance of each phonetic variant of *some* when 4 of 4 agents completed an activity. Note that the higher the acceptance for a phonetic variant, the fewer implicatures were generated. By accepting that "some kids" completed an activity when all kids completed the activity, the "some, but not all" implicature was not generated. A table summarizing each participant's acceptances can be found in the appendix.

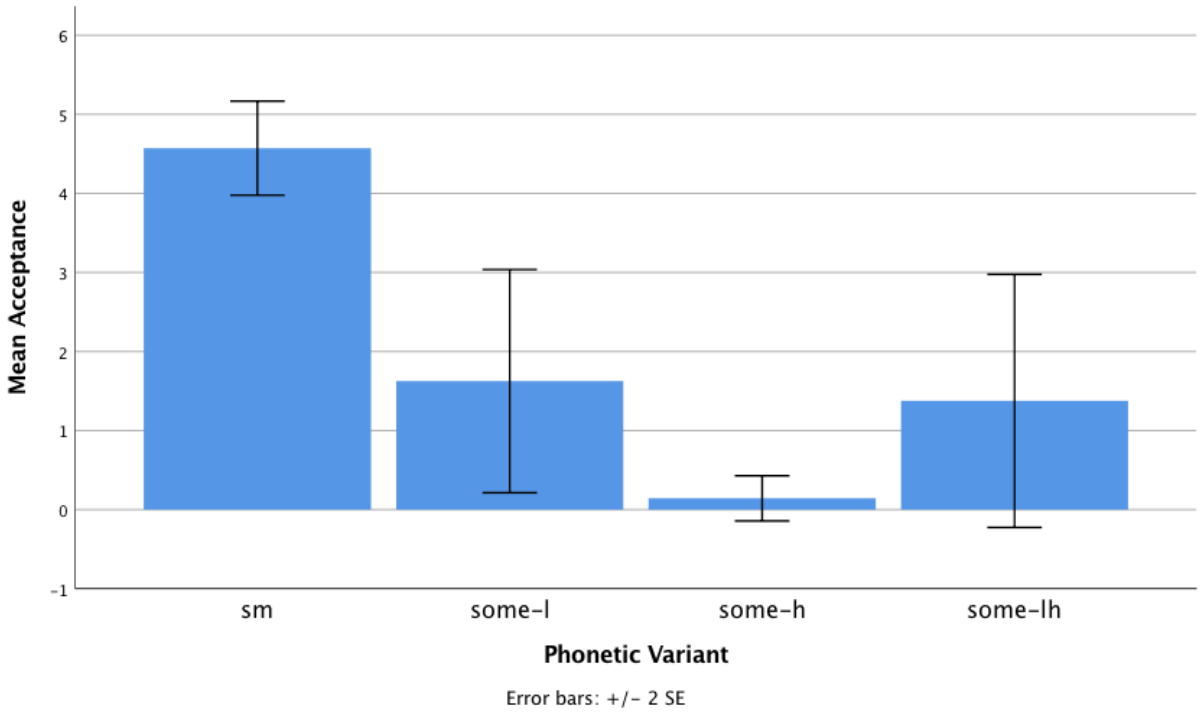

Figure 13: Mean acceptance of "some" in 4 of 4 cases for each phonetic variant

A one-way ANOVA test of the results was performed to see if any of the responses for each of the phonetic variants differed significantly. The results of the ANOVA test indicate that the deleted vowel "sm" form is statistically different from all other phonetic variants of *some* tested $f(3,26) = 9.435$, $p < .001$). A summary of the post-hoc, least significant differences test can be found below in Table 3. All other phonetic variants of *some* were not statistically different from each other ($p > .05$).

Sm	Variant of *some*	*p* value
	some full vowel, unaccented	.002
	some full vowel, accented	< .001
	some pitch accented (L+H*)	.001

Table 3: Post-hoc, least significant differences test results for "sm"

Chapter 4: Discussion

Implicatures were generated at roughly the same frequency between the full vowel unaccented “some” case, the full vowel accented “sOme” case, and the pitch accented “SOME” case. This can be seen through Figure 13 by the similar low acceptance bars in the cases where 4 of 4 agents completed an activity. A low acceptance bar means high levels of a “some, but not all” implicature generation and vice versa. There were significantly fewer implicatures generated in the deleted vowel “sm” case than the cases involving the other three phonetic variants of *some*.

The results from this experiment give evidence to suggest that adult English speakers rely more heavily on quantifier vowel duration than pitch when determining whether or not to generate an implicature. The only phonetic variant that differed significantly from the others was the deleted vowel “sm” case. As seen in Figures 8-12 and Table 1, “sm” was distinguishable by the quantifier word length and vowel length. The pitch of the deleted vowel “sm” case was not distinct. Therefore, we have evidence to suggest that the vowel/word length of the quantifier *some* is the relevant factor in implicature generation. These results contradict our hypothesis based on evidence from previous research (Grinstead, 2010). The study done by Grinstead in 2010 suggested that the pitch of the quantifier *some* was a more important factor than vowel length in implicature generation.

With this information, our hypothesis is that “sm” is a separate lexical item from *some*. Therefore, when someone hears “sm,” they are not treating it as the word *some*, but rather something completely different. This would explain why the acceptance rate was significantly different from the rest. By deleting the vowel, it becomes a new lexical item. Further research could be done to further support this idea

Another direction of future research for this topic could be with English-speaking children. The results could be compared with these adult results to understand at what point children develop the cognitive resources to produce adult-like responses dealing with the quantifier *some*. Also, further testing could be done with the executive function tasks to see if attention, inhibition, or working memory correlate with the acquisition of adult-like responses in children.

Chapter 5: References

Carlson, G. (1977). Reference to Kinds in English. (PhD Doctoral Dissertation), MIT, Cambridge.

Grice, H. P. (1975). Logic and conversation. 1975, 41-58.

Grinstead, J., Thorward, J., Ross, S., & Maynell, L. (2010). Vowel reduction, pitch accent and scalar implicatures in child English. In Proceedings of the Annual Boston University Conference on Language Development (Vol. 1, pp. 138-149).

Gutierrez-Rexach, J. (2001). The Semantics of Spanish Plural Existential Determiners and the Dynamics of Judgment Types. Probus, 13(1), 113-154.

Gutierrez-Rexach, J. (2010). Varieties of Indefinites in Spanish. Language and Linguistics Compass, 680-693.

Miller, K., Schmitt, C., Chang, H., & Munn, A. (2005). Young children understand some implicatures. In Proceedings of the 29th annual boston University Conference on Language Development (pp. 389-400). Somerville, MA: Cascadilla Press.

Milsark, G. (1977). Toward an Explanation of Certain Peculiarities of the Existential Construction in English. Linguistic Analysis, 3, 1-29.

Noveck, I. A. (2001). When children are more logical than adults: Experimental investigations of scalar implicature. Cognition, 78(2), 165-188.

Papafragou, A., & Tantalou, N. (2004). Children's computation of implicatures. *Language acquisition*, *12*(1), 71-82.

Postal, P. (1964). Limitations of Phrase Structure Descriptions. In J. K. a. J. Fodor (Ed.), Readings in the Philosophy of Language. Englewood Cliffs, NJ: Prentice-Hall.

Pouscoulous, N., Noveck, I. A., Politzer, G., & Bastide, A. (2007). A developmental investigation of processing costs in implicature production. Language acquisition, 14(4), 347-375.

Smith, C. L. (1980). Quantifiers and question answering in young children. Journal of Experimental Child Psychology, 30(2), 191-205.

Stalnaker, R. (1974). Pragmatic Presuppositions. In M. Munitz & D. Unger (Eds.), Semantics and Philosophy (pp. 197-213). New York: New York University Press.

Teresa Guasti, M., Chierchia, G., Crain, S., Foppolo, F., Gualmini, A., & Meroni, L. (2005). Why children and adults sometimes (but not always) compute implicatures. Language and cognitive processes, 20(5), 667-696.

Vargas-Tokuda, M., Grinstead, J., & Gutiérrez-Rexach, J. (2009). Context and the scalar implicatures of indefinites in child Spanish. Hispanic Child Languages, 93-115.

Appendices

Executive Function Task Scores/Acceptance

ID	Age (months)	Flanker	Set Shifting	Dot Counting	Condition	Acceptance of "some" in 4 of 4 cases (out of 5)	Acceptance of "some" in 3 of 4 cases (out of 5)
1-1A	263	8.946	8.747	15	Full vowel, accented	0	5
2-1A	259	9.203	9.274	19	Full vowel, accented	0	5
3-2A	236	9.574	8.709	20	Deleted vowel "sm"	5	5
4-2A	234	9.243	9.25	21	Deleted vowel "sm"	0	5
5-3A	247	8.957	6.707	20	Pitch accented "SOME"	0	5
6-3A	263	8.995	8.012	19	Pitch accented "SOME"	0	5
7-4A	257	9.23	9.219	21	Full vowel, unaccented	0	5
8-4A	227	8.098	6.902	18	Full vowel, unaccented	0	5
9-1A	256	9.437	9.509	18	Full vowel, accented	5	5
10-2A	221	9.445	9.328	25	Deleted vowel "sm"	5	5
11-3A	237	9.414	7.687	15	Pitch accented "SOME"	0	5
12-4A	248	9.558	9.222	17	Full vowel, unaccented	5	5
13-1A	269	9.204	5.749	23	Full vowel, accented	1	5
14-2A	261	9.257	8.647	13	Deleted vowel "sm"	5	5
15-3A	237	6.445	6.903	27	Pitch accented "SOME"	0	5
16-4A	231	9.588	9.075	26	Full vowel, unaccented	2	5
17-1A	263	8.779	7.022	25	Full vowel, accented	4	5
18-2A	230	8.77	8.86	22	Deleted vowel "sm"	3	5
19-3A	250	8.844	9.134	13	Pitch accented "SOME"	1	4
20-4A	269	9.353	8.387	23	Full vowel, unaccented	2	5
21-1A	231	8.315	9.619	9	Full vowel, accented	0	5
22-2A	224	9.219	9.757	13	Deleted vowel "sm"	5	5
23-3A	253	9.274	8.234	11	Pitch accented "SOME"	5	5
24-4A	230	9.276	8.335	14	Full vowel, unaccented	4	5
25-1A	234	9.64	9.272	20	Full vowel, accented	0	4
26-2A	230	9.275	8.466	25	Deleted vowel "sm"	4	5
27-3A	266	9.284	8.393	16	Pitch accented "SOME"	5	5
28-4A	236	8.523	7.401	14	Full vowel, unaccented	0	5
29-1A	233	9.278	8.685	16	Full vowel, accented	0	5
30-2A	228	8.519	7.511	22	Deleted vowel "sm"	5	5
31-3A	264	9.137	8.56	24	Pitch accented "SOME"	0	5
32-4A	251	8.368	6.689	12	Full vowel, unaccented	0	5
33-1A	261	9.078	9.193	15	Full vowel, accented	0	4

Target Sentences

Some kids went down the slide.
Some kids climbed the ladder.
Some kids jumped over the fence.
Some kids crossed the street.
Some kids went around the bus.

Warmup and Filler Sentences

All the kids went in the pool.
No kids went in the pool.